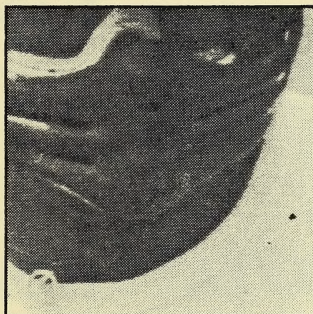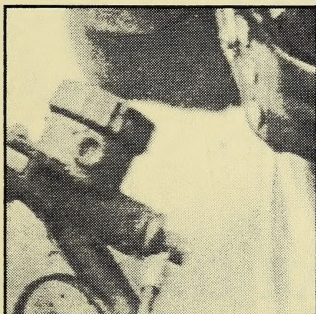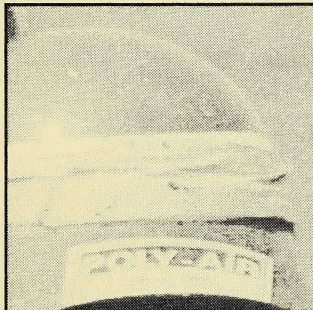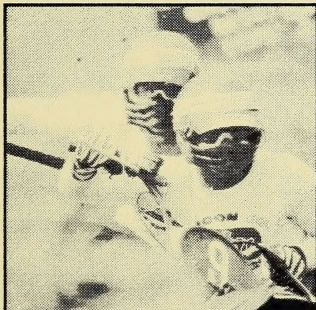# SCIENCE 14

MODULE 2: TECHNOLOGY IN ACTION

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Learning Facilitator's Manual

Distance Learning

Alberta
EDUCATION

Science 14

Module 2

LEARNING FACILITATOR'S MANUAL

Note

This Science Learning Facilitator's Manual contains answers to teacher-assessed assignments; therefore, it should be kept secure by the teacher. Students should not have access to these assignments until they are assigned in a supervised situation. The answers should be stored securely by the teacher at all times.

Module 2 – Technology in Action: Overview

This module continues the philosophy presented in Module 1, with the emphasis on having students **do** things, **make** things, and **test** things. Simple machines, electricity, and magnetism are presented in the first two sections of this module. In Section 3 the student is asked to complete a case study of complex technology. The materials required to complete the investigations in this module can all be found in the home. It is hoped that the student will begin to appreciate the impact of technology on everyday life.

TECHNOLOGY IN ACTION

Section 1: Simple Machines
- basic types of simple machines
- working laws for simple machines
- simple machines in everyday life

Section 2: Electricity and Magnetism
- description of electricity
- relationship between electricity and magnetism
- examination of how some electrical devices work

Section 3: Complex Technology
- case study of the electric guitar
- case study of the bicycle

Materials You Need

Section 1: Activity 1

- spoon
- a metre stick (any type of board will do)
- a bunch of similar weights (pennies, washers, etc.)
- a fulcrum (a dowel, frying pan handle, rolled up newspaper, etc.)
- a ruler
- tools or kitchen utensils

Section 1: Activity 2

- a flat board (about 1 m long)
- books
- ruler
- an empty 1 L or 2 L milk carton
- elastic band (long ones are best)
- water
- tools or kitchen utensils

Section 1: Activity 3

- three metres of rope
- two chairs

Section 1: Enrichment

- bicycle
- chalk

Section 2: Activity 1

- comb
- bits of paper
- metal spoon

Section 2: Activity 2

- aluminum foil
- battery
- flashlight bulb

Section 2: Activity 3

- three electrical appliances

Section 2: Activity 4

- sewing needle
- glass of water
- piece of wood, wax, or cork
- magnet
- battery
- your compass (or a manufactured one)
- aluminum foil
- insulated wire
- nail

Section 2: Enrichment

Burglar Alarm

- thin metal strips
- insulated wire
- battery
- screws
- buzzer or bell

Homemade Electric Motor

- 60 cm copper insulated wire (#22 to #30)
- two paper clips
- one or two magnets
- 6 volt battery
- electrical tape
- two connecting wires

Section 3: Activity 6

- bicycle
- watch or clock

Additional Resources

Applied Science, Book One G. Wilde. Melbourne, Australia: Longman Cheshire, 1986.

Domestic Electricity Harlow, England: Longman UK, 1985.

Electronics Harlow, England: Longman UK, 1985.

Gears and Gearing Harlow, England: Longman UK, 1985.

Principles of Science, Book Two Columbus, Ohio: Merrill, 1979.

Science, Technology, and You Glen Hutton. Scarborough: Globe/Modern Curriculum Press, 1989.

Possible Media

Video Series - *The Acme School of Stuff*

Video - *Science and Technology: Acting in Turn*
This video focusses on the evolution of the gear, with many applications of gears shown (19 minutes).

Video - *Simple Machines*
This video shows six simple machines and more complex machines. The importance of simple machines in everyday life is stressed.

Video - *Flip a Switch*

This video is available on free loan from TransAlta Utilities. The production of electricity in a coal-fired generating station is shown.

Contact: TransAlta Utilities
Public Affairs Department
Box 1900
Calgary, Alberta
T2P 2M1

Most videos can be obtained through your regional media centre or through ACCESS Network.

Some of the suggested media may not be authorized by Alberta Education. Teachers should use their own discretion regarding the use of these resources in their classroom.

Evaluation

The student's mark in this module can be determined by their work in the Assignment Booklet. Each student must complete all assignments. In this module the student is expected to complete three section assignments. The assignment breakdown is as follows:

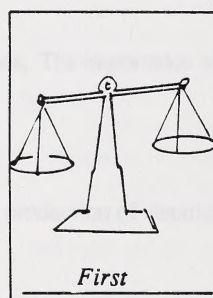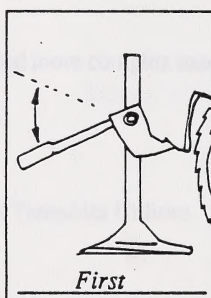|		
Section 1	=	35 marks
Section 2	=	35 marks
Section 3	=	30 marks
TOTAL	=	100 marks

Teachers may also award marks for attendance, neatness, classroom participation, etc.

Section 1: Simple Machines

Each of the six simple machines is introduced and examples of them are explored. The emphasis of this section is on the household use of simple machines. A field trip to an industrial plant containing an assembly line, such as a pop bottling plant, might enhance student interest.

Section 1: Activity 1

1. These are all pictures of levers. Classify them as first-class, second-class, or third-class levers.

First   *Third**   *Second*

Second*   *First*   *First*

Teacher Comment: *The shovel is a third class lever while throwing dirt.
                   *The pry bar can be a first class lever if used differently.

2. Which end is easier to push?

    The handle end is easier to push.

3. Why doesn't the eating end stay down when you push on the other end?

    The handle end is longer. It has an advantage over the eating end.

4. Why can't you lift the handle by pushing on the eating end if your finger is on the handle end?

    The handle end is longer, giving it the advantage over the eating end.

Investigation: Is There a Relationship Between the Distance from a Fulcrum and the Effect of the Force at That Position?

Observations

Number of Weights	Distance from Fulcrum (cm)	Number of Weights	Distance from Fulcrum (cm)
8	<u> 20 </u> *	8	20
4	<u> 40 </u> *	8	20
6	<u> 27 </u> *	8	20

Teacher Comment: *The students results shoud be pretty close as long as their weights are the same.

Conclusions

Multiply the number of weights by the number of centimetres the weights are away from the fulcrum for each part of the chart.

Weight × distance should always equal 160 or be close to that number.

5. Do the multiplications for the example shown.

	Force × distance =
Resistance arm	*(500 N)(50 cm) = 25 000 N • cm*
Effort arm	*(250 N)(100 cm) = 25 000 N • cm*

6. Changing a car tire involves lifting one-quarter of the car's weight. This can be 3000 N (about 300 kg). Suppose that a car jack is a lever with an M.A. of ten. With what force would you have to push down on the jack to lift the car?

$$M.A. = \frac{resistance}{effort} \qquad 10 = \frac{3000}{effort} \qquad effort = 300 \ N \ (about \ 30 \ kg)$$

You would have to exert a force of 300 N on the jack to lift the car.

7. Name the wheel and axle described in each of the following descriptions. They can be found around most houses.

   a. turns bolts into a hole

   wrench

   b. a toy with two wheels on an axle on a string

   yo-yo

   c. with a turn it changes the amount of light in a room

   dimmer switch

8. Examine a toolbox and find four examples of levers. State whether the mechanical advantage of each is greater or less than one. You may include any wheel and axle devices as well.

   Toolbox

   Possible answers are

   - *hammer – less than one when pounding*
             – greater than one when pulling nails out
   - *wrench – greater than one*
   - *screwdriver – greater than one*
   - *pliers – greater than one pinching, and greater than one turning*

   There are others as well.

9. Examine the utensils in a kitchen and find four examples of levers. State whether the mechanical advantage of each is greater or less than one. You may include wheel and axle devices as well.

   Kitchen

   Possible answers are

   - *bottle opener – greater than one*
   - *can opener – greater than one*
   - *meat mallet – less than one*
   - *toenail scissors – greater than one*
   - *paper scissors – less than one*
   - *nutcracker – greater than one*

   There are others as well.

Section 1: Activity 2

1. The mechanical advantage of an inclined plane is (greater /less) than one. (circle one)

Investigation: To Find the Mechanical Advantage of an Inclined Plane

Be sure to pull with a slow, **steady** hand. The elastic will not stay at one length, so you must estimate the average.

Conclusions

2. What happens to the stretch as your inclined plane gets steeper?

    The stretch gets longer as the ramp gets steeper.

3. Does the stretch going up the inclined plane ever come close to the resistance stretch?

    If so, when?

    Yes, when the ramp is very steep.

4. Compare the work done with the ramp to the work done without the ramp.

    There is more work done with the ramp.

5. How do you explain the relationship between work done with and without the ramp?

    Friction is responsible for the extra work done with the ramp.

6. Suppose you are lifting a 500 N object a distance of 1 m. You use a 3 m long ramp to do this. If your effort is 250 N, then what is the mechanical advantage of your ramp?

    $$\frac{resistance}{effort} = \frac{500\ N}{250\ N} = 2$$

    The ramp has a mechanical advantage of 2.

7. What should the mechanical advantage be in theory?

$$\frac{length}{height} = \frac{3\,m}{1\,m} = 3$$

In theory, the mechanical advantage should be 3.

8. Examine a toolbox and find two examples of wedges, and two examples of screws.

Toolbox

Possible answers are

wedge – saw blade, tin snips blade, chisel
screw – screws, bolts, crescent wrench tightener, drill bit

9. Examine kitchen utensils and find two examples of wedges, and two examples of screws.

Kitchen

Possible answers are

wedge – knife blades, scissors blades, can opener blade, spatula
screw – corkscrew, jar lid (any twist lid)

Section 1: Activity 3

1. Here are two examples of the pulley principle being used to lift an object.

a. What is the difference between them?

The pulley (wheel) is attached to the branch. Otherwise, the branch acts as the wheel.

b. Which is easier to use?

The wheel is easier to use.

c. Why?

There is much less friction using the pulley.

2. a. Which chair moves toward the other?

The other person's chair will move towards your chair.

b. Why?

The rope going around the chair leg is like a moveable pulley. The force you exert is multiplied by two on the other chair.

3. Suppose you wanted the sign to move faster than the motor. How could you do this with the same gears?

Putting a larger gear on the motor and a smaller one on the sign will make the sign move faster than the motor.

4. Block and tackle systems are common on larger sailing boats. Sea cadets are quite familiar with them. Why are they so useful on a sailboat?

Block and tackle systems have large mechanical advantages. This is necessary to pull in a sail against the large force of the wind.

Section 1: Follow-up Activities

Extra Help

1. Name the type of simple machine found in each of the following devices:

a. nutcracker

lever (2nd class)

b. socket wrench

wheel and axle

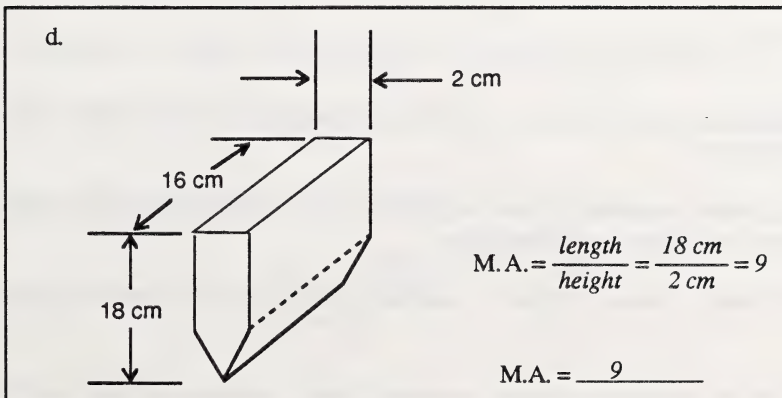c. meat cleaver

wedge

d. ramp

inclined plane

e. bolt

screw

2. A car jack has a mechanical advantage that is quite large. Suppose you can push with a 250 N force, but you must lift 3500 N of weight to change a tire. What mechanical advantage do you need?

$$M.A. = \frac{resistance}{effort} = \frac{3500\ N}{250\ N} = 14$$

You need a mechanical advantage of 14.

3. Fill in the blanks in these diagrams.
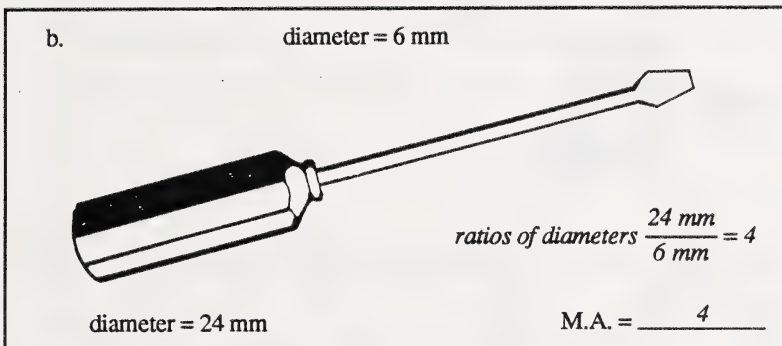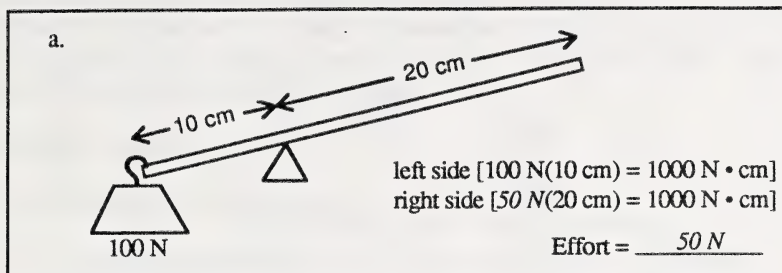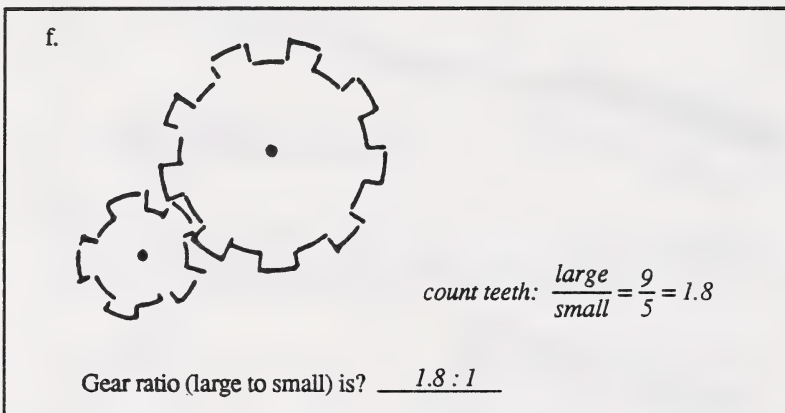
a.

20 cm

10 cm

100 N

left side [100 N(10 cm) = 1000 N • cm]
right side [*50 N*(20 cm) = 1000 N • cm]

Effort = ___50 N___

b.

diameter = 6 mm

diameter = 24 mm

ratios of diameters $\dfrac{24\ mm}{6\ mm} = 4$

M.A. = ___4___

c.

4 m

1 m

$M.A. = \dfrac{length}{width} = \dfrac{4\ m}{1\ m} = 4$, *so force needed is 100 ÷4 = 25 N*

Force needed to push a 100 N weight up the ramp is ___25 N___

d.

2 cm

16 cm

18 cm

$M.A. = \dfrac{length}{height} = \dfrac{18\ cm}{2\ cm} = 9$

M.A. = ___9___

e.

Type of pulleys   *fixed pulleys*

f.

$$count\ teeth:\ \frac{large}{small} = \frac{9}{5} = 1.8$$

Gear ratio (large to small) is?   *1.8 : 1*

Enrichment

1. Try to go one day **without** using any simple machine. Watch yourself very carefully. Can you do it?

    I can't do it!

2. Investigate the gears of a derailleur-type bicycle. (ten-speed, twelve-speed, etc.) Are all the gear ratios different?

    *This depends on your bike. It's common for different combinations to have the **same** gear ratio. A ten-speed doesn't have ten **different** gears.*

Teacher Comment: Be sure and check the students' answers against their reported number of teeth.
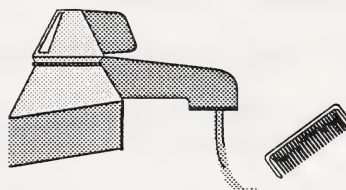
Section 2: Electricity and Magnetism

This section begins with an explanation of static and current electricity. Electrical devices in the home are explored. Finally, the study of magnets and their relation to electricity leads to a discussion about motors and generators. Where possible, household activities and examples are used. A field trip to a power station or dam would be useful for this section.

Section 2: Activity 1

1. Try these tests with static electricity.

   a. Comb your hair and bring the comb near a trickle of water. What happens?

   The water is attracted to the comb.

   b. Take some clothes with static on them into a dark closet and pull them apart. What do you see?

   You see tiny sparks.

   c. Rub your feet on a rug, and then touch a metal object. What happens?

   You get a shock.

2. If a positive charge is near a negative charge, what do you think might happen?

   The extra electrons from the negative charge will jump over to make up for the lack of electrons on the positive charge (a spark occurs).

3. If two negatively charged balloons drifted close together, what would they do?
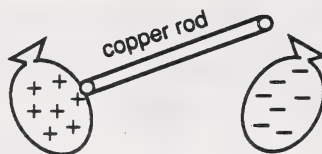
   They would repel (push away from each other).

4. Look at this diagram. Predict what will happen when the glass rod touches both balloons?

   Nothing, glass is an insulator. No electrons move, so the charges remain on the balloons.

5. In this case a copper rod is used. Predict what will happen when the copper rod touches both balloons?

The extra electrons on the negative balloon go through the copper rod to the positive balloon (copper is a conductor) until the number of electrons even out.

Section 2: Activity 2

1. Look at a small battery. What is the voltage printed on it?

    It probably has 1.5 volts (a bit less if it's a nickel-cadmium rechargeable battery), 6 volts if it's a lantern battery, or 9 volts if it's one of these.

2. If a flashlight uses two batteries and you hook up five batteries to its bulb, predict what will the bulb do?

    The bulb will burn out.

    Why? *The filament will get too hot and melt.*

3. If a bulb burns out, is the circuit open or closed?

    The circuit is open.

    Why? *The broken filament acts like a switch to break the circuit.*

4. a. The energy difference in a circuit is the *voltage*.

    b. The rate of flow of electricity is the *amperage*.

Investigation A: A Quick Flashlight

STEP B Touch a corner of the foil on the side of the bulb.	OBSERVATION
	Did the bulb light? How does electricity go through the bulb? (What path?) *The bulb does light up. Electricity goes up the bottom of the bulb, through it, and out the side.*

Conclusions

Did you need a wire? Why or why not?

No, you did not need a wire. The foil is as good as a wire.

Investigation B: Flashlight Parts

Take a flashlight apart and see if you can trace the circuit the electricity makes.

Different flashlights vary. Look for a metal contact on the bottom of the battery (or batteries). The bulb usually rests on the top of the battery. The flashlight case itself can be the wire back from the bulb.

Section 2: Activity 3

1. What's the difference between how an electric stove and a toaster work?

    The stove uses more current so that it can get hotter.

2. a. If 1 kW • h of energy costs 5.5¢, and you use 6 kW of power for 3 hours, how much will that cost?

    $6\ kW \times 3\ h = 18\ kW \cdot h \times 5.5¢ = 99¢$

    b. If you leave a 100 W light bulb on for 3 hours, how much will that cost?

    $100\ W = 0.1\ kW \times 3\ h = 0.3\ kW \cdot h \times 5.5¢ = 1.65¢\ (cheap!)$

3. Electrical appliances have a message plate on them that tell you how much electricity they use. Read the plates of three of the following appliances. Fill in the chart for the ones you choose. Remember:

volts × amps = watts

Appliance	Volts	Amps	Watts
toaster	120	7.5 - 10.4	900 - 1250
electric kettle	120	10.4 - 12.5	1250 - 1500
stereo component	120	0.0417	5
60W light bulb	120	0.5	60
electric heater	120	6.25 - 12.5	750 - 1500
electric drill	120	2 - 3	240 - 360
radio (plug in type)	120	0.5	30 W per channel (60 total)
circular saw	120	6 - 9	720 - 1080

Note: Your values may differ from these. These are ballpark figures.

Teacher Comment: Look for consistency with the formula.

4. Will the breaker (fuse) blow if you plug the following appliances into one circuit?

    150 W bulb
    650 W car heater
    900 W toaster

    Total watts = 1700 W
    Total amps = 14.2 A
    The breaker won't blow. It is close to blowing, but the circuit should take the load.

Section 2: Activity 4

Investigation: Building a Compass

Observations

Fill the glass full. Sooner or later the float moves to the centre.
If you can't find a moving magnet, stroke the needle over a fixed one (in a speaker, refrigerator door, etc.).

1. a. Does the needle point to geographical north? (Streets run north-south; your house is probably built in a north-south orientation.)

   The needle points close to north-to-south.

   b. Is it off from geographical north to south a bit?

   The needle is off to the east.

Investigation: Electromagnetism

Observations

Use an AA size battery, or smaller if possible. A D-cell battery heats the aluminum quite fast.

2. What did the compass needle do here?

   The compass needle moved away from the N-S direction when the foil came close to the needle.

3. What did the compass needle do here?

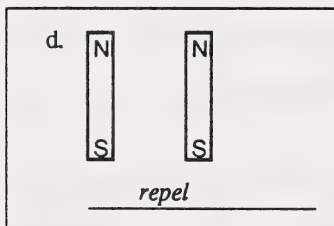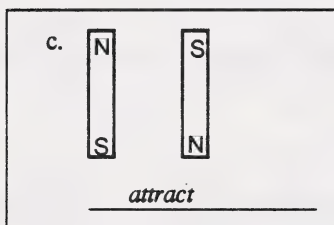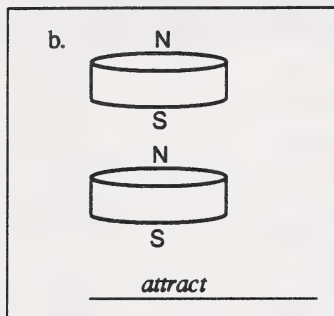   *It went back to N-S when contact with the battery was broken.*
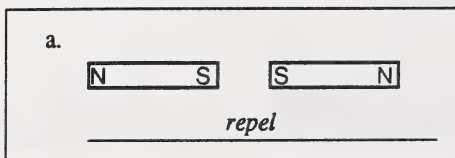
4. What did the compass needle do here?

   The needle moved away from the N – S direction again.

5. What similarities do magnetism and electricity have? (Name two.)

   They have two types of things in common (charges and poles); opposites attract, like things repel.

6. What would the magnets do in each of the following cases
    (attract or repel)

a.

| N   S | | S   N |

repel

b.

N

S

N

S

attract

c.

N		S
S		N

attract

d.

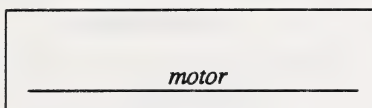| N | | N |
| | | |
| S | | S |

repel

7. Think of a use for an electromagnet. Remember: You can turn off the magnetism by turning off the electricity.

    Lifting scraps of metal (old cars) and dropping them can be done with an electromagnet. (Any answer that indicates that a magnet is used to pick something up and then drop it is acceptable.)
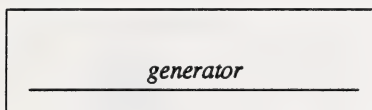
Section 2: Activity 5

1. Move a wire past a magnet. You will get an *electric current*.

2. Put electricity through a wire near a magnet. The wire will *move*.

3. **Electricity** ➝ **Movement**
   Device

motor

4. **Movement** ➝ **Electricity**
   Device

generator

5. If you needed to make electricity and all you had was an old motor, how would you do it?

   You would connect the motor's shaft to something that could turn it. This would produce electricity.

Section 2: Follow-up Activities

Extra Help

1. Complete this chart.

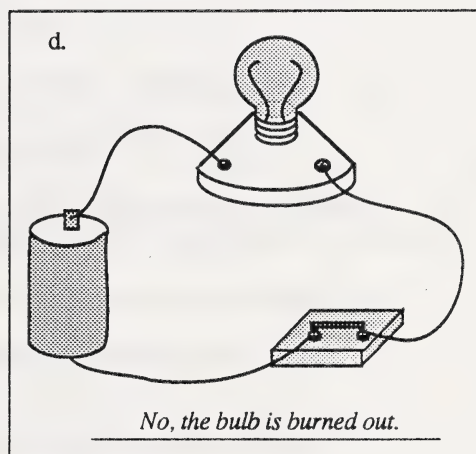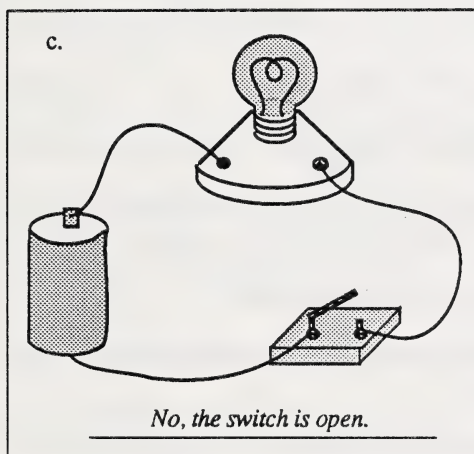|	
things that give us electricity	a. *electrons*
b. *too many electrons*	negative charge
too few electrons around	c. *positive charge*
two negative charges close will	d. *repel*
e. *lets electrons move*	conductor
won't allow electrons to move	f. *insulator*

2. Give two examples of insulators:

    Examples of insulators are glass, air, pure water, plastic, and rubber.

3. Give two examples of conductors:

    Examples of conductors are aluminum, copper, dirty water, or any metal.

4. Will the light go on in each of these circuits?

a.

No, the light socket isn't connected.

b.

Yes, the light will go on.

c.

No, the switch is open.

d.

No, the bulb is burned out.

5. If a drill uses 4 amps of current, how many watts is it using? (Remember there are 120 V in a house.)

volts × amps = watts
120 × 4 = 480 watts

6. A soldering iron has a rating of 80 W. How many amps does it use?

  volts × amps = watts
  120 × amps = 80
  $amps = \dfrac{80}{120} = 0.67\ amps$

7. An electric heater has a rating of 1500 W. If you leave it on all night (8 hours), how many kW•h did you use?

  1500 W = 1.5 kW × 8 hours = 12 kW • h

8. Electric currents produce heat. Name three devices that use this idea.

  Some devices are stoves, ovens, toasters, fuses, circuit breakers, and heaters, as well as many other devices.

9. These magnets attract. Label the poles of the second magnet.

10. What device shows that electric currents have magnetic fields?

  The electromagnet shows that electric currents have magnetic fields.

11. What name is used to show that magnetism and electricity are two parts of one thing?

  Electromagnetism is the term used to show that magnetism and electricity are two parts of one thing.

12. Electromagnetism is based on two phenomena. Fill in the following chart.

Generator Effect	Motor Effect
A moving ____wire____ in a ____magnetic field____ produces _electricity_ .	Running _electricity_ through a wire near a ___magnet___ makes the wire ____move____ .
A generator turns __movement__ into _electricity_ .	A motor turns _electricity_ into _movement_ .

Enrichment

1. Pure water is an insulator. Why is it said that water and electricity don't mix?

   Dirty water conducts electricity quite well. However, it isn't the water that's the conductor. Substances in the water, such as minerals, work as conductors. Wet electrical devices can kill people if the electricity is grounded through them.

2. Check one circuit in your home and find out how many amps are on it.

   Turn a breaker off and check which plug-ins and lights don't work. Use a lamp as a tester.

3. Build a burglar alarm for your room (or any room). Here are some instructions. (Be sure and get permission before pounding nails into the door frame.)

   It takes careful adjusting (bending) of the clips to fine-tune the alarm.

4. Make a homemade electric motor. Here are some plans for you.

   Don't put too much current through your motor or you will melt the insulation and burn it out. It takes a lot of fiddling to get it to work – don't give up too easily.

Section 3: Complex Technology - A Case Study

In this section students choose to examine either an electric guitar or a bicycle as an example of complex technology. Both case studies may be done if the student has the time and the interest. Each case study reviews the major parts of the technology and how they work. Guest speakers such as a musical sound person or a cycling racer would enrich this section.

Section 3: Activity 1

1. a. What can you say about the lengths of the strings?

   All the strings are the same length.

   b. What can you say about the thickness of the strings?

   The thicker the string, the lower the pitch.

2. The tuning pegs, or machine heads, adjust the strings by tightening or loosening them. Describe two ways in which simple machines are used to give you a great mechanical advantage in doing this.

   • *The worm gear turns many times to make the main gear turn once.*
   • *The knob on the end is a wheel and axle with the worm gear (much like a screwdriver).*

3. Which of the laws of stretched strings have been used to tune the guitar?

   The Law of Tension and the Law of Thickness have been used to tune the guitar.

4. a. What does pressing your finger behind a fret do to the string?

   Pressing your finger behind a fret pins the string to a fret, thus making the string shorter.

   b. What effect will this have on the pitch of the note?

   By doing this, the pitch will be raised.

   c. Which law of stretched strings does this use?

   The Law of Length causes this to happen.

Section 3: Activity 2

1. Can electric guitar strings be made of nylon?

   Why or why not?

   No, nylon is an insulator. The generator effect needs a metal wire (string) moving in a magnetic field.

2. If you only had an electric guitar and an amplifier, could you hear yourself play?

   Why or why not?

   No, the amplifier can't convert electricity into sound. A speaker is required to convert the electricity into sound. Some amplifiers have speakers.

Section 3: Activity 3

1. Label the part shown and explain its function.

   A: *pickup*

   - *turns string vibrations into electric signals*

   B: *amplifier*

   - *boosts weak guitar signal*
   - *sends a strong signal into speakers*

   C: *speaker*

   - *turns electric signal back into sound*

2. Suppose that you are the sound person for this performer. The following problems occur. Suggest ways to fix each problem.

   a. There is no sound from **one** speaker.

      The trouble is probably in the speaker. This could be due to a loose cord connection, a bad cord, or the amplifier may be broken in that one connection.

   b. There is no sound from **either** speaker.

      The trouble is probably in the amplifier or guitar. This could be due to an unplugged amplifier, or the guitar cord could be faulty or badly connected.

c. There is intermittent sound from **both** speakers.

A poor connection from the guitar to the amplifier is the probable cause. Check the cord connections or replace the cord.

d. As the sound person, what extra equipment would you have for this performer?

Carry extra cords! Back-up amplifiers and speakers are expensive, and it is time-consuming to replace them.

Section 3: Activity 4

1. a. How many speeds are on this bike?

    There are ten speeds on this bike.

    b. What is the mechanical advantage of high gear?

    $$\frac{14}{52} = about\ 0.27$$

    The M.A. is 0.27.

    c. What is the mechanical advantage of low gear?

    $$\frac{28}{40} = 0.70$$

    The M.A. is 0.70.

Teacher Comment: Gear ratios are usually listed the other way. i.e. $\frac{52}{14} = \frac{26}{7} = 3.7$
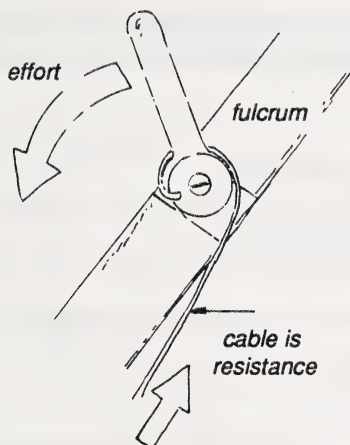
$$\frac{40}{28} = \frac{10}{7} = 1.43$$

2. All the mechanical advantages are less than one. What does this mean?

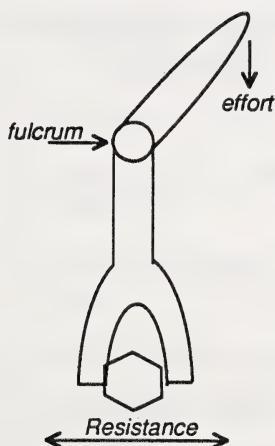   *If the M.A. is less than one, you gain distance and lose force.*

3. a. What type of lever is the control lever?

   The control lever is a wheel and axle or second-class lever.

   b. There is another lever in the derailleur. Describe how it works.

   The changer pivots on a fulcrum. The cable supplies the effort, and the chain puts up the resistance (first-class lever).

4. The control lever pulls or pushes a cable which pushes the chain off one gear and onto another. Can you see why you change gears while pedalling? What would happen if you change gears while coasting?

*The chain won't slip off the gear unless you push **hard**. If you change while coasting, it will wreck the gear and chain. (If the gears are turning while you shift, they will slip off one gear and onto the next.)*

Section 3: Activity 5

1. How does speed affect wind resistance?

As speed increases, so does wind resistance.

2. As the body positions get lower, the wind resistance goes down. Why?

As you go lower, you expose less area to the wind.

3. Why would racers prefer light oil to grease?

Light oil has less friction and only has to last for the race.

4. Why would a city driver be better off using grease?

A city driver would be better off to use grease, because it increases protection and decreases maintenance. Loss of friction isn't crucial for commuting.

Section 3: Activity 6

Investigation: Cycling Strategies

Observations

1. Describe your course.

   length in kilometres:

   description:

   You will decide the length of the course. Just be sure to write it down. Description: Include whether your course is hilly or level; if there are traffic signs or lights; and what type of surface you are riding on (pavement, dirt, etc.).

Teacher Comment: Look for completeness of answers. There is not a wrong or right answer, but answers must be consistent.

2. Strategy 1 – One (Or Just a Few) Gear(s)

   a. time to complete: *The time taken to complete the course will depend on you.*

   b. how you feel afterwards: *Use phrases to describe how tired you are (if you are sweating, if you have any muscle cramps, etc.). If you know how, take your pulse rate, too.*

3. Strategy 2 – Constant Rate of Pedaling

   Rate of pedalling – 60 pedals per minute suggested (Racers can do 90.)

   a. time to complete: *The time taken to complete the course will depend on you.*

   b. how you feel afterwards: *Describe as in Strategy 1.*

Conclusion

4. Based on your trials, which is the better way to cycle?

   You make the decision. Time might be your deciding factor, but also consider how tired you were afterwards.

5. List one advantage and disadvantage of each strategy in the following chart.

	Constant Gear	**Constant Pedalling**
Advantage	• *simple, no gears to worry about* • *safe, can watch traffic better*	• *most efficient method, uses the least energy* • *easier on knees*
Disadvantage	• *one gear wears out faster* • *harder on your body if you have hills, stops, etc.*	• *takes quite a bit of practice* • *distracts you from traffic until you're good at it*

You may have found other advantages and disadvantages as well.

Section 3: Follow-up Activities

Extra Help

1. Which complex device from the right has the parts listed on the left?

	Parts		**Complex Device**
__B__	lens, motor, shutter	A.	car
__C__	lobe, three bones, cochlea	B.	camera
		C.	human ear
__A__	engine, transmission, exhaust	D.	human eye
__D__	lens, cornea, retina, optic nerve		

2. Here are some subsystems of a car.

    - engine
    - transmission
    - brakes
    - carburetor
    - power train
    - exhaust
    - electrical
    - fuel

    Which system needs fixing if

    a. it can't stop?

    brakes

    b. it won't shift gears properly?

    transmission

    c. it won't "turn over" when starting?

    electrical

    d. you smell gases when driving?

    exhaust

Enrichment

1. Tune up your bicycle yourself. There are many books available that tell you how.

   *One book is **Anybody's Bike Book** by Tom Cuthbertson. It is published by Ten Speed Press.*

2. Research how a microphone works

   Try to find out how it turns sound into electricity. The rest is the same as the guitar.

3. Research how a transistor works.

   Look up semiconductors; transistors use them.

Module Summary

Complex technology is based on simpler technology. This module examined simple machines, electricity and magnetism, and simpler technologies used in many complex devices. The student should become aware of how technology is everywhere and in almost everything they do. Wrap-up activities for this module could include a Rube Goldberg fest or a cycling ralley.

Key to the Assignment Booklet

Section 1 Assignment (35 marks)

(6 marks) 1. No machine is 100 percent efficient. **All** machines lose energy to friction. Explain where the friction is in two of these machines.

- a teeter-totter
- a loading ramp
- two gears meshed directly

- *teeter-totter – Much of the friction exists in the pivot. It's usually so bad that you can hear squeaks.*

- *a loading ramp – Sliding friction exists between a box (or whatever) and the ramp. If a wheeled dolly is used, the wheels will have some friction in them.*

- *two gears – Gears are designed to fit perfectly, but the sides of the teeth rub from one gear to the next. This causes friction.*

(5 marks) 2. You gain force and lose distance or gain distance and lose force with a machine. What stays constant? Why?

The gain in force is matched by the loss in distance, so force × distance is constant. This is the work done at both "ends" of the machine. Since work done means energy used, the energy is constant. Conservation of energy is basic to any situation.
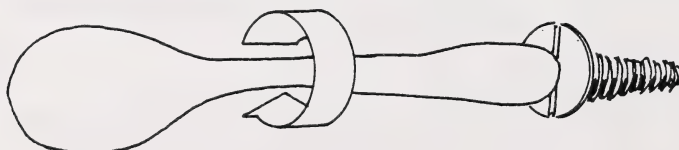
(10 marks) 3. Suppose you're given a spoon; describe how to use it as a lever, a wheel and axle, a wedge, a pulley, and an inclined plane. Invent a task to do with each in order to help your description.

Expect lots of different responses here, some very creative.

lever – *shoot an eraser*

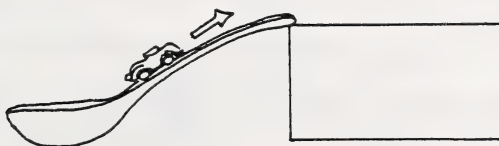wheel and axle – *tighten a screw*

wedge – *scrape a dirty pan*

pulley – *lift a potato (string over spoon in any form)*
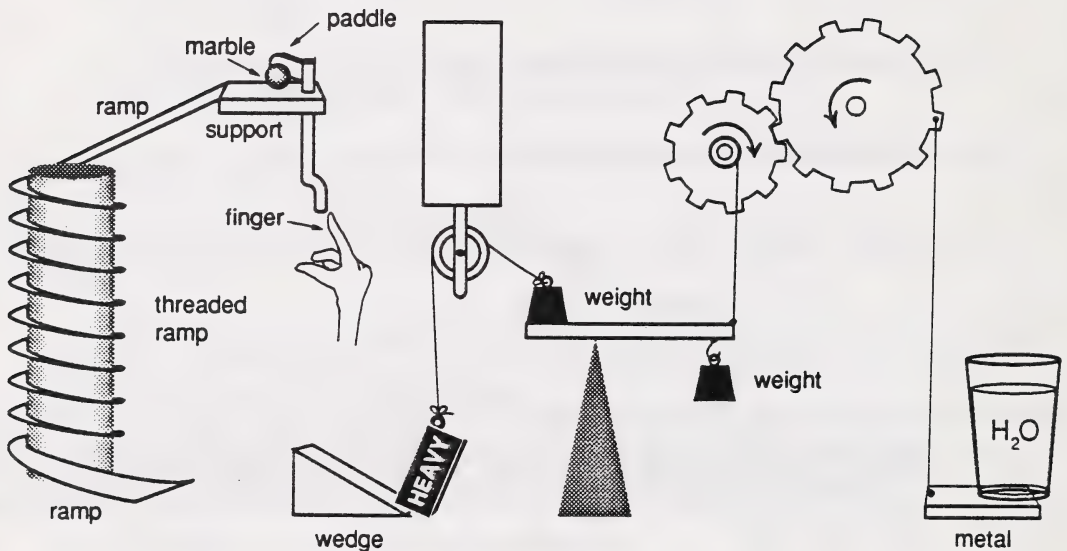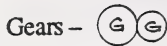

inclined place – *pull a toy car up a ramp*

(14 marks) 4. Invent and draw a diagram of a gadget that will push over a glass of water. It must start with you pushing your finger on something. You will get two marks for each different simple machine in your gadget. (For example: pushing a lever which turns a gear, which pushes the glass over is worth four marks). If you don't draw well, use the following symbols for your machines. Describe how each part should work.

Lever –

Pulley –

Inclined Plane –

Wedge –

Screw –

Gears –

Wheel and Axle –   or   or

paddle
marble
ramp
support
finger
threaded
ramp
ramp

weight
weight

H₂O

metal

wedge

Award two marks for each simple machine if the gadget could work; one mark for each simple machine if the gadget is there, but probably wouldn't work. Here's an example of one that would receive full marks.

A marble is pushed down a ramp with a paddle.
*(**inclined plane** and **wheel and axle**)*

*The marble hits the **wedge** at the bottom, after going around the thread.*
*(**screw**)*

*A heavy bar falls, using a **pulley** to lift the weight off the end of the **lever**.*

*The lever falls and turns the **gears** (wheel and axle on first gear too).*

The second gear lifts the metal thing under the glass and tips it over.

Section 2 Assignment (35 marks)

(4 marks) 1. Lightning kills people every year. Suppose you are very close to a bolt of lightning. It misses you. What injury might you suffer? Assume that nothing else hits you and that no electricity reaches you.

There are two strong possibilities. First, a burn could result if the lightening starts a fire from which you can't escape. You also could suffer from smoke inhalation. The other possibility, which is not uncommon, is ear damage caused by the thunder. Thunder that close to a lightening strike is quite loud. There may be other reasonable possibilities as well.

(4 marks) 2. A person sent an expensive battery to a friend. He wrapped it carefully, first in aluminum foil and then in paper, and then he sent it by mail. Why was this not a smart thing to do?

The foil completes the circuit from the positive to negative poles of the battery. If he's lucky, the receiver will get a dead battery. If he's unlucky, a fire will start somewhere.

(6 marks) 3. a. If you rub a balloon and put it on a wall or ceiling, it will stick. Why?

The balloon picks up a static electric charge and attracts the wall.

b. Why does cling-wrap plastic stick so well to dishes?

Cling-wrap picks up a static charge when unrolling. It attracts most dishes (and really attracts itself).

(5 marks) 4. Fix this circuit so that the light goes on. (The diagram is on the response page.) There are several things wrong with the circuit. Write what to do on the diagram.

There are five things wrong with the circuit. The light will go on if you

- *join the batteries (or by-pass one).*
- *replace the bulb – its filament is broken.*
- *replace the fuse – it's blown.*
- *re-connect the wire on the switch. Move the left wire to the middle.*
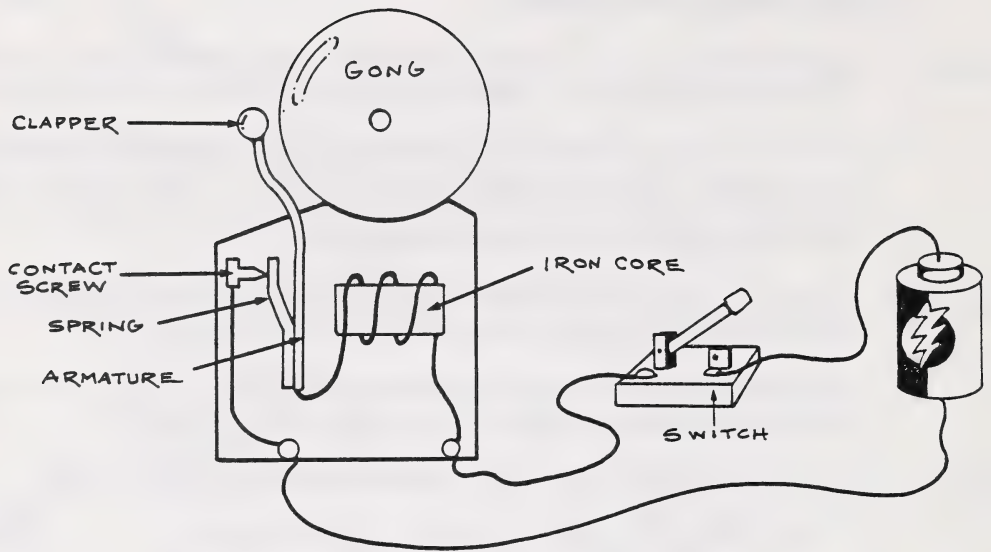- *connect the wire to the left terminal of the socket.*

(6 marks) 5. a. The north pole of the magnet in a compass points to the Earth's north magnetic pole. What does this say about the Earth's north magnetic pole? Why?

The Earth's north magnetic pole is really a south pole (magnetically speaking). A north pole of a magnet attracts a south pole – opposites attract.

b. There are places in Colorado where there is a great quantity of iron-bearing rock in the mountains. How will a compass perform there?

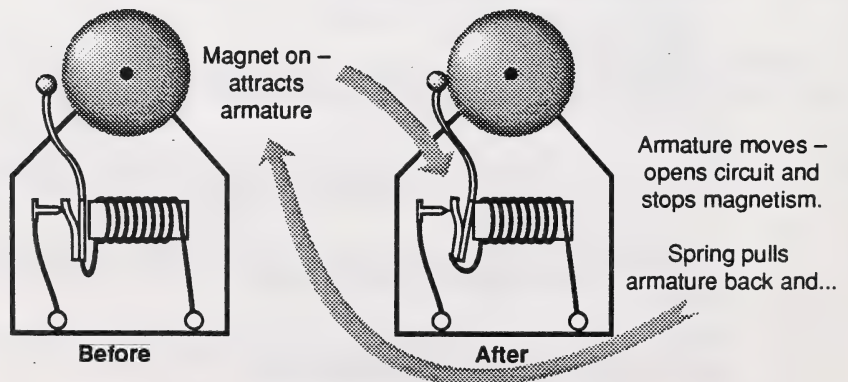*The compass will be useless. It will point to a nearby iron deposit – not to magnetic north.*

Bell

(10 marks) 6. a. What will happen when the electric circuit is closed in the diagram? Why?

The clapper hits the gong – lets go – hits it again – lets go, and so on until the switch is opened. Here's why; the clapper is "pulled" into the gong by the electromagnet. The movement of the clapper breaks the circuit and turns off the electromagnet. This allows the clapper to return to the resting position, completing the circuit and starting the cycle again.

b. Draw what the bell will do when the switch remains closed. Two diagrams are needed to show how the bell works. (Hint: You can do some research to find out how a bell works.)

Section 3 Assignment (30 marks)

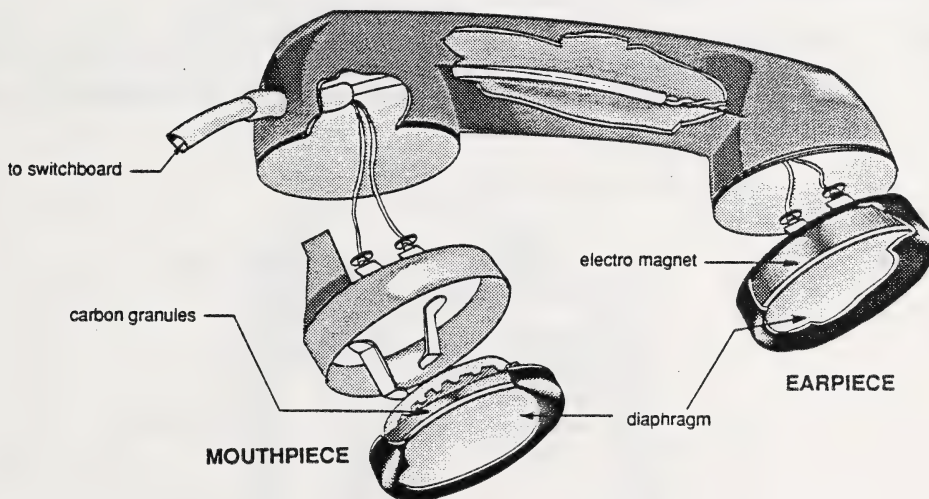Note: Complete the questions that apply to the case study that you did.

Case Study – Electric Guitar

(15 marks)   1.   A telephone uses the same three steps that the guitar, amplifier, and speaker do. Describe these steps and explain how the telephone uses them. Use a diagram to help your explanation.

The three steps are

(1)   • *sound to electricity*

(2)   • *amplify the signal and transport it*

(3)   • *electricity to sound*

Teacher Comment: Look for these three steps in the diagram.

to switchboard

electro magnet

carbon granules

EARPIECE

diaphragm

MOUTHPIECE

(3) *The current reaches the earpiece and activates an electromagnet connected to another diaphragm. The diaphragm vibrates to produce sound.*

(1) *Sound vibrates the diaphragm, which compresses the carbon granules attached to it. This changes the current in the microphone that is in the mouthpiece.*

(2) *The current goes to the switchboard for routing and amplifying.*

2. How do you decide what is a good guitar, amplifier, or speaker as compared to a poor one?

The important thing is true production of sound at as loud a volume as possible. You don't want distortion, buzzing, or loss of any of the frequencies. The speakers must match the amplifier. The amplifier has to drive the speakers, and therefore needs enough power to do this. However, if the amplifier has too much power for the speakers, the speakers will be ruined. A really good amplifier also has abilities to change the sound by adding such features as reverberation, distortion, and echo. It will also be able to handle several inputs at a time.
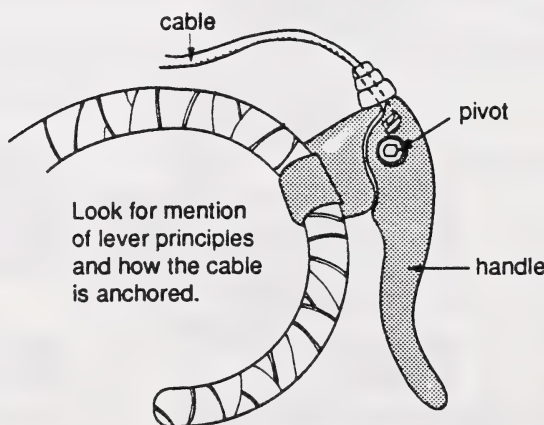
The speakers should produce highs and lows equally well. They will be big and heavy to push out sound waves without being affected.

The guitar must first be a good musical instrument. Its electrical components will be of high quality and be able to pick up all the tones played.

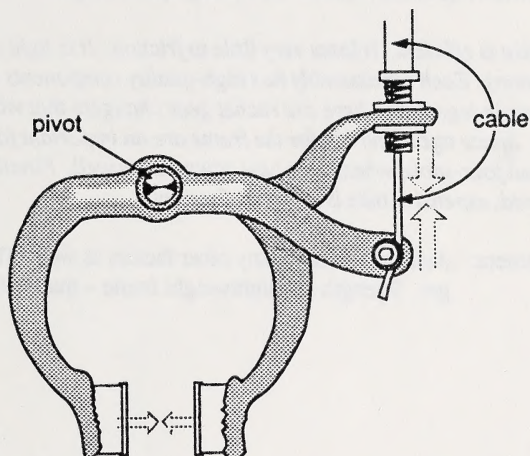Teacher Comment: There are other things too. If they are reasonable answers, give credit.

Case Study – Bicycle

(15 marks)   1.   A bicycle has another system on it that uses cables – the brakes. Look at your bike and draw a diagram of the brake system (one wheel is enough). Label the diagram to show how the system works. Note: Diagram a hand brake system, not a coaster brake system found on a one-speed bike.
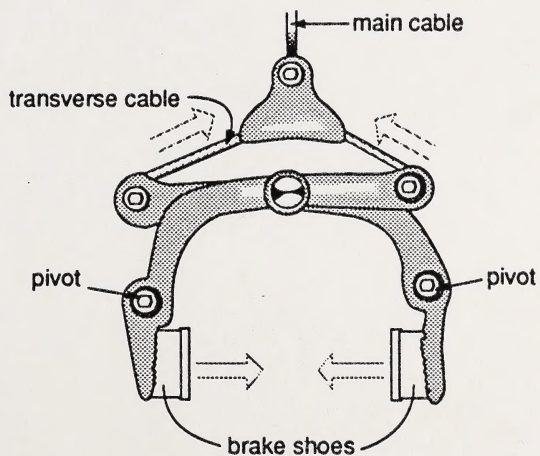

cable

pivot

Look for mention of lever principles and how the cable is anchored.

handle

Pull the handle in and it pivots (lever). The cable is attached to the handle and is pulled away from the wheel.

Side Pull Brake

*The cable pulls up and half of the brake pivots (lever)
and pushes the brake shoes or the wheel rim. Friction
stops the bike. The other shoe scissors in as well.*

Centre Pull Brake

*The cable pulls up and a transverse cable pulls on both
sides and the shoes grab the wheel rim.*

(15 marks) 2. How do you decide what a good bike is compared to a poor one?

Your answer to question 2 should be a paragraph in length.

A good bike is efficient. It loses very little to friction. It is light and strong (an expensive combination). Each subassembly has high-quality components that do the job well. Gears and the chain wear in together. There are rachet gear changers that will change gears perfectly at the flip of a switch. Space age materials for the frame are an important factor in a high-quality bike. Disk wheels and four-spoke wheels are new advances as well. Finally, a well-tuned bike is a good one. A badly-tuned, expensive bike is a waste of money.

Teacher Comment: Again, there are many other factors as well. They depend on the use the bike will get. Strength and lightweight frame – that's where the money is.

This booklet cannot be purchased separately; the
Learning Facilitator's Manual for Science 14
is available only as a complete set.

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